BULLETIN

OF THE

Society

FOR THE

Promotion of Engineering Education

Volume III

PUBLICATION COMMITTEE
W. T. MAGRUDER W. G. RAYMOND
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BULLETIN

OF THE

Society for the Promotion of Engineering Education

Vol. III LANCASTER, PA., SEPTEMBER, 1912 No. 1

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EDITORIALS.

Efficiency in Administering College Affairs.—In the present number of the BULLETIN several writers call attention to the need for better methods for use in conducting college work. There is need here for improvement just as there is such need in manufactories and in power plants. There is no merit in self-satisfaction along this line for a strong sentiment for improvement prevails among administrators of college affairs. On the whole the results of past efforts have

been reasonably satisfactory and teachers should not be discouraged by the prevalent criticism of their work. Most of this criticism aims to be constructive. The well-balanced teacher is neither complacent nor discouraged but accepts criticism in the spirit in which it is given and applies such suggestions as fit his case.

The papers on efficiency, presented at Boston, deal with several phases of the subject. Several took up the general philosophy of efficiency, others showed how this philosophy can be applied to college work, and still others discussed the curriculum of a course in efficiency engineering. As a whole this collection of papers is unique and every effort will be made to get the material before the members of the Society promptly. Practically the entire space in the BULLETIN will be used for the purpose until all of the papers have appeared. Then a volume of reprints will be made up and published.

Results to be Expected from the Boston Meeting.—The Boston program was designed to be practical, with a view to definite and immediate advance in enthusiasm and method. While the number of papers was so great as almost to cause confusion, they all bear a definite relation to the one subject, improvement in college administration. Fortunately, many influential educators were present and they need not wait for the publication of the papers to apply the suggested plans. A tangible evidence of the practical nature of the meeting is found in the demand for the appointment of committees to conserve and formulate the suggestions brought out in the papers and discussion. These committees were promptly appointed and are already actively at work. What they do will be a measure of the value of the Boston meeting.

The Circulation of Committee Reports.—The concrete work of this and other societies is that done by committees. This Society has now in excellent form for circulation several such reports. Of particular immediate reference value are the reports of the Committee on Engineering Degrees, the Com-

mittee on Entrance Requirements, and the Committee on Teaching Mathematics to Students of Engineering. These reports should be in the hands of every person who is in a position to benefit from them. The burden of placing these reports where they will achieve results now rests upon the members of the Society.

NEW MEMBERS.

The Council has elected at the annual meeting in Boston the applicants whose names are listed on pp. 526, 527 and 528 of the June BULLETIN and below.

ADAMS, CONRAD A., Instructor in Mechanic Arts, Tufts College, Tufts College, Mass. 1912
BLACK, R. M., Instructor in Civil Engineering and Mechanics, State University of Iowa, Iowa City, Ia. 1912
BROWN, F. D., Consulting Engineer, City Hall, Shawnee, Okla. ... 1912
CLARK, J. C., 1312 Center St., Wilkinsburg, Pa. 1912
COOPER, F. L., Instructor in Physics, Yale University, New Haven, Conn. 1912
CRAWFORD, WM. C., Master, Boston Industrial School for Boys, Boston, Mass. 1912
DENNISON, B. C., Assistant Professor of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1912
DOBBS, F. E., Instructor in Estimating and Practical Mathematics, Wentworth Institute, Boston, Mass. 1912
FISH, E. H., Director, Worcester Trade School, Worcester, Mass. . 1912
HAMILTON, J. McC., President, Montana State College of A. & M. Arts, Bozeman, Mont. 1912
HAMLIN, H. L., Director of Printing, Boston Industrial School for Boys, Boston, Mass. 1912
HEUTER, R. R., Instructor in Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass. 1912
HIGGINS, CHAS. H., Consulting Engineer, Princeton University, Princeton, N. J. 1912
HILL, WM. W., Professor of Electrical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1912
HOLBROOK, E. A., Assistant Professor in Mining Engineering and Metallurgy, Nova Scotia Technical College, Halifax, N. S. ... 1912
KING, CARL, Instructor in Material of Construction, Wentworth Institute, Boston, Mass. 1912

KINSEY, A. S., Supervising Instructor of Shop Practice, Stevens Institute of Technology, Hoboken, N. J. 1912
LETELLIER, L. S., Professor of Drawing, The Citadel, The Military College of South Carolina, Charleston, S. C. 1912
NYSWANDER, R. E., Professor of Physics, University of Denver, Denver, Colo. 1912
O'NEILL, J. F., Instructor in Mechanic Arts, Massachusetts Institute of Technology, Boston, Mass. 1912
PARMLY, CHAS. H., Associate Professor of Physics, The College of the City of New York, New York City 1912
RICHARDSON, G. R., Instructor in Steam Engineering, Franklin Union, Boston, Mass. 1912
RODGERS, L. J., Instructor in Machine Shop Practice, Wentworth Institute, Boston, Mass. 1912
SANBORN, F. B., Professor of Civil Engineering, Tufts College, Tufts College, Mass. 1912
SORENSEN, R. W., Professor of Electrical Engineering, Throop Polytechnic Institute, Pasadena, Calif. 1912
STEELE, J. N., Instructor of Foundry Work, Jersey City Technical High School, Jersey City, N. J. 1912
SUTTIE, R. H., Assistant Instructor in Civil Engineering, Sheffield Scientific School, Yale University, New Haven, Conn 1912
TUCKER, J. I., Associate Professor and Director of the School of Civil Engineering, University of Oklahoma, Norman, Okla. .. 1912
WAGNER, W. C., Instructor in the Department of Electrical Engineering, University of Washington, Seattle, Wash. 1912
WHITAKER, M. C., Professor of Industrial and Engineering Chemistry, Columbia University, New York, N. Y. 1912
WILSON, GEO. S., Assistant Professor in Mechanical Engineering, University of Washington, Seattle, Wash. 1912

APPLICANTS FOR ADMISSION.

BROWN, B. H., Professor of Physics, Whitman College, Walla Walla, Wash. 1912
HARRIS, L. H., Assistant Professor of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1912
MALLORY, FRANCIS, Professor of Physics and Electrical Engineering, Virginia Military Institute, Lexington, Va. 1912
MORRISON, I. F., Lecturer in Civil Engineering, University of Alberta, Edmonton, South Alta, Canada 1912
MULDOWNEY, J. W., Instructor in Heating and Ventilating, Franklin Union, Boston, Mass. 1912

ROBERTS, T. M., Professor of Electrical Engineering, Delaware College, Newark, Del. 1912
TAYLOR, L. B., 131 Westmont Ave., Haddonfield, N. J. 1912
WEBB, H. E., Head of the Department of Mathematics, Central Commercial and Manual Training High School, Newark, N. J. 1912

SPECIAL COMMITTEES FOR 1913.

In accordance with the instructions of the council the program committee has appointed the following committees:

Four committees on cooperation in engineering education in the four divisions: (Mining) Prof. F. W. Sperr, chairman, Prof. E. A. Holbrook, Prof. J. B. Porter, Prof. H. H. Stoek, Director L. E. Young; (Civil) Prof. F. P. McKibben, chairman, Prof. A. N. Talbot, Mr. G. S. Williams, Prof. H. S. Jacoby, Prof. E. D. Walker; (Mechanical) Prof. A. M. Greene, Jr., chairman, Prof. C. Russ Richards, Prof. W. F. Durand, Prof C. C. Thomas, Prof. J. T. Faig; (Electrical) Prof. C. F. Scott, chairman, Prof. W. I. Slichter, Prof. C. F. Harding, Prof. H. H. Norris, Prof. G. B. Thomas.

A committee on college administration has also been appointed, comprising Dean F. L. Bishop, chairman, President C. S. Howe and Dean A. S. Langsdorf.

OFFICERS, 1912–1913

President,

WM. T. MAGRUDER, Columbus, O.

Vice-Presidents,

L. S. MARKS, Cambridge, Mass., F. W. SPERR, Houghton, Mich.

Secretary,

H. H. NORRIS, Ithaca, N. Y.

Treasurer,

WM. O. WILEY, New York City.

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E. E. BRYDONE-JACK, Winnipeg, Manitoba,
W. H. P. CREIGHTON, New Orleans, La.,
J. F. HAYFORD, Evanston, Ill.,
C. R. RICHARDS, Urbana, Ill.,
H. W. TYLER, Boston, Mass.,

whose terms of office expire in 1913.

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C. E. CROUCH, Grand Forks, N. D.,
F. L. EMORY, Morgantown, W. Va.,
C. E. MAGNUSSON, Seattle, Wash.,
H. H. STOEK, Urbana, Ill.,
J. A. L. WADDELL, Kansas City, Mo.,
A. J. WOOD, State College, Pa.,

whose terms of office expire in 1914.

F. L. BISHOP, Pittsburgh, Pa.,
G. R. CHATBURN, Lincoln, Nebr.,
O. P. HOOD, Pittsburgh, Pa.,
F. P. MCKIBBEN, South Bethlehem, Pa.,
G. D. SHEPARDSON, Minneapolis, Minn.,
W. B. SNOW, Boston, Mass.,
J. C. TRACY, New Haven, Conn.,

whose terms of office expire in 1915.

Past-Presidents—Members Ex-Officii

G. F. SWAIN, Cambridge, Mass., C. FRANK ALLEN, Boston, Mass.,
MANSFIELD MERRIMAN, N. Y. City, F. W. MCNAIR, Houghton, Mich.,
H. T. EDDY, Minneapolis, Minn., C. L. CRANDALL, Ithaca, N. Y.,
T. C. MENDENHALL, Ravenna, O., D. C. JACKSON, Boston, Mass.,
IRA O. BAKER, Urbana, Ill., CHAS. S. HOWE, Cleveland, O.,
F. O. MARVIN, Lawrence, Kans., F. E. TURNEAURE, Madison, Wis.,
ROBERT FLETCHER, Hanover, N. H., H. S. MUNROE, New York City,
C. M. WOODWARD, St. Louis, Mo., A. N. TALBOT, Urbana, Ill.,
W. G. RAYMOND, Iowa City, Iowa.

PERSONAL NOTES.

Dr. Wm. Paul Gerhard, the well-known Consulting Sanitary Expert, is leaving shortly for Europe, to attend the International Conference on Public and School Baths at Scheveningen, Holland, as the official delegate representing the United States. He will also attend the "City Planning Exhibit," at Düsseldorf, Germany.

Maj. W. W. Crosby, after twenty-five years' experience in various kinds of engineering practice, the last fifteen years of which have been devoted almost exclusively to road and street work, has resigned as chief engineer of the state roads commission of Maryland, and has established offices at Baltimore, Md., where he will engage in private practice.

PUBLICATIONS RECEIVED.

PAMPHLET containing a "General Statement of the Contents of 'THE CORTHELL LIBRARY,' in the John Hay Library Building at Brown University, Providence, R. I. This Library is a collection made during forty-five years of professional work as a Civil and Consulting Engineer, interested also in Geography, Science and Engineering Education." Among the publications of the many Societies of which the founder, Elmer Lawrence Corthell, Dr.Sc., is a member appears the complete collection of S. P. E. E. Proceedings (19 volumes), and also an extensive number of reports of investigations on Engineering Education.

SOUTHERN GOOD ROADS. The June issue contains contributions by two of the leading highway engineers of this country: Professor Arthur H. Blanchard, of Columbia University, and Major W. W. Crosby, who recently resigned as chief engineer of the Maryland State Roads Commission to enter private practice. Both Professor Blanchard and Major Crosby are actively interested in the relation of their work to Engineering Education.

THE PRESENT STATUS OF THE DIESEL ENGINE IN EUROPE AND A FEW REMINISCENCES OF THE PIONEER WORK IN AMERICA, by Dr. Rudolph Diesel. A lecture delivered before Sibley College, Cornell University, U. S. Naval Academy, The Associated Engineering Societies of Saint Louis, and The American Society of Mechanical Engineers, during April, 1912. Copies of this illustrated report will be forwarded to members of the Society who are interested, by addressing the Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo.

PROCEEDINGS of the Eighth Annual Convention of the AMERICAN ROAD BUILDERS ASSOCIATION. This contains a report of the interesting sessions held at Rochester, N. Y., last November. Among the list of officers and speakers appear the names of a number of prominent engineers who also take an active part in S. P. E. E. work.

ENGINEERING BULLETIN No. 2, of the Engineering Experiment Station, of the University of Kansas, Lawrence, Kansas.—"Natural Gas: Its Properties, Its Domestic Use, and Its Measurement by Meters," prepared by P. F. Walker, Professor of Mechanical Engineering.

REPRINT (in German) from "TECHNICK UND WIRTSCHAFT," the monthly journal of the Verein Deutscher Ingenieure, on the subject of Cooperation of American Engineers in American Engineering Education. ("Amerikanische Ingenieure über amerikanische Ingenieurerziehung"), by Dr. C. Matschoss. Professor Dr. Conrad Matschoss is Dozent of the Royal Polytechnic High School of Berlin and is also intimately connected with the work of the Deutscher Ausschuss für technisches Schulwesen, an organization very similar to this Society. We shall be honored very soon by a visit to this country by Dr. Matschoss in connection with a tour of America to study the methods of educating young engineers.

EDUCATIONAL DEMANDS OF MODERN PROGRESS.

BY HARRINGTON EMERSON,

President of The Emerson Company, New York City.

Erie is a fairly peaceful lake, quite navigable by sailors of ordinary prudence and skill.

Ontario, further down stream, is another peaceful lake, also quite navigable by sailors of ordinary prudence and skill.

Between the two lakes courses the Niagara River. No amount of skill, no prudential methods insuring success on Lake Erie are of any use in the rapids above and below the falls, especially of no use in the thousand feet of swirl which include the cataract. If the boatman can make the portage from the upper to the lower lake, he may again use his old skill.

But Lake Ontario narrows into the St. Lawrence and in time this river broadens out into the Atlantic. Even the skill of the French Canadian pilot through the rapids of the St. Lawrence would not avail, would not fit him to navigate either sailer or steamer across the great oceans. The qualities of courage, resourcefulness, calmness will count, but not previously-acquired specific knowledge of streams and shores.

Time is also a river. It also has its lakes, its rapids and its issuance into a limitless ocean.

We, voyagers down the river, are now already in the stormy channel between two epochs. As never before in the history of the world has past knowledge, past experience, past skill, counted for so little, and never before in the history of the world have men been so poorly prepared for what was ahead of them.

Go back in Europe, one, five, ten, fifteen centuries, and it is routine that counted. The lives of 95 per cent. of men and women were fixed by status. The man died of old age near

where he was born, working at his father's and grandfather's trade. As with Chinese women, it was absolutely necessary to begin mental, physical, moral foot-bindery at the earliest possible age. The Arabs are living to-day as they lived in the time of Abraham. Neither their language, nor their customs, nor their clothes, nor their food has changed. Forty years ago in Germany, in Italy, in Greece little girls were taught to knit and spin and were kept at it every possible minute from dawn until dusk, until death came to them as old women. Routine training was all important because routine work constituted nearly all of the world's work.

But routine training has not fitted the boatman on the waters of life to cope with the rapids between one epoch and another, has particularly not fitted the boatman who has floated down a narrow river confined by the banks of routine to navigate a limitless ocean.

At El Tovar, on the brink of the Grand Cañon of the Colorado, is a battered boat. It belonged to two inexperienced men who, in it, came down the full length of the river. Although the Colorado is one of the most difficult and dangerous rivers in the world, even danger can belong to routine. Each rapid is largely a repetition of the others. These men acted with typical routine inspiration. They floated their boat down stern foremost, rowing against the current, pointing at what was behind and not at what was ahead.

This simile likening time to a river, likening disturbing epochs to cataracts, likening the future to the limitless ocean, may be picturesque, but I shall justify it.

When previous experience of an industrial kind is not available, then we must use contemporary experience of a similar kind.

Races of plants, of insects, of animals, have met crises for which previous experience was not available. Those who made the most mistakes perished; those who made the fewest, survived. The survivors can give us suggestions.

The aphides, plant insects, are normally without wings. One generation succeeds another with monotonous regularity.

There is nothing to do but stick fast to the particular plant until its leaves have been devoured or are withered. When famine occurs what do the aphides do? The next generation has wings and flies away. Those who fail to grow wings perish.

Bees similarly work day after day with all the discipline and habit of routine. It looks as if no change could ever come. Suddenly routine is wholly forgotten. A swarm gathers, abandons the hive, the accumulated stores, the location, everything that made bee life worth while, and, hanging to some tree, waits while scouts seek some new refuge, the hollow of a tree, a crevice in the rocks. The race of bees is preserved in these crises, not by routine, but by desperate and to man inconceivable initiative.

Among the migratory birds we find the same hints. The stork is the emblem of domesticity. On the roof tree it occupies the same nest year after year; it is counted on to bring babies to human homes, but when winter comes it forgets domestic routine and departs. A stork marked in Norway was captured a few weeks later in South Africa.

Hatched in the cool waters of a mountain stream, salmon, when partly grown, swim down and out into the salt sea. Where they stay for three years no one knows. They break away from the routine of the river and go out into a new life for which no previous experience has prepared them. At the end of four years, giving up the routine of the sea, they return to ascend rivers, to leap up waterfalls, to lead a life which is wholly and absolutely new.

In man infancy and youth are marked by crises by which a comparatively long period of routine is broken by great and revolutionary initiative. There are sudden and tremendous changes, from ovum to embryo, from foetus to breathing life, from birth to weaning, from childhood to puberty.

Whether insects, fish, birds or men, when the crises come, only those who develop intiative, who forget routine, who look ahead and not backwards, survive. We therefore find that initiative alternates with routine as part of the law of progress.

But are we now in a period of transition, a peculiar epoch, an age requiring for survival initiative and not routine? If we are in such an epoch, then it is immensely important to free ourselves from the trammels of routine and to grow the wings of initiative. Those who do not will perish.

Let me demonstrate to you by a single example that we are in this epoch of transition. To bring out the difference between the old order and the new, I shall compare the generation of power in China and in America. Make no mistake! The difference is not one of race capacity. The yellow race is as numerous as the white, it has counted among its members great religious teachers, the greatest of conquerors, the greatest of artists, it has evolved a civilization that has endured two thousand years. We fear the Chinese as we do not fear negroes, Indians or Mexicans. We fear them on account of their superlative qualities. The difference at the present time between the white and yellow is not one of race capacity but solely of opportunity.

In China men are paid $0.01 an hour for climbing treadmills actuating stern wheels which propel river boats. These coolies convert their stored human muscular energy into mechanical foot-pounds. From experience with treadmills in British prisons we know exactly the mechanical equivalent of hard labor. It is a climb of 8,640 feet each 24 hours. This is the limit of human endurance for a succession of days. To convert this into horse-power we must know the man's weight and the number of hours he works each day. The average weight of man is about 150 pounds. A man of this weight climbing 8,640 feet in 24 hours yields 1,296,000 foot-pounds. A horse-power for 24 hours is 47,520,000 foot-pounds. It would therefore take 36.6 Chinamen to yield a continuous horse-power and the wages of these Chinamen would amount to $3.66 per day, or $1,336 a year.

From Niagara you can buy a horse-power year for $20. It costs the paper mills which have their own power about $12 a year for continuous horse-power. Human energy at $0.10 a day costs one hundred and ten times as much as this water-

power energy, although the supervising human labor receives an average of $3 a day.

The substitution of uncarnate energy for human muscular energy has increased wages thirty-fold and has cheapened power to 1 per cent. of its cheapest muscular price. This is not all. When men are used as power generators the supply is strictly limited and can be easily monopolized. Uncarnate energy is without limit as long as there is coal and oil and gas, as long as the sun shines and makes organic fuels or draws up water from the surface of the ocean.

For strictly limited horse-power at $1,336 a year we now have unlimited horse-power at a minimum price of $12.

We have brought about this gigantic change in conditions not by adhering to routine but by abandoning it. This example could be paralleled in every direction.

The ability to use without limit cheap power has revolutionized all conditions. To spade up a section of land would take an active man's energy for 500 years. With oil power tractors and gang plows three men can turn over 640 acres of land in 36 hours. It is good hard work to make a broad jump of 20 feet at a speed of 10 miles an hour, rising 4 feet from the ground, but aeroplanes at the international contest this year will fly 80 miles at a speed which may reach 110 miles an hour, and fly as easily at an altitude of 5,000 feet as at 50. Formerly a man could carry a maximum load of 100 pounds; to-day his trains drag 6,000 tons and his ships carry 30,000 tons. Formerly a man's voice carried 500 feet; now as he sits at his desk he can reach with his voice 20,000,000 names, some of them a thousand miles away.

I do not consider myself an old man, yet almost nothing of engineering importance to-day was taught when as a youth I went to one of the foremost technical schools in the world, and almost nothing that I there specifically learned has any value to-day. I learned from Weissbach's great work how to design Dutch windmills and overhead water wheels, but not a word of dynamos or motors, of telephones, of gas engines or of gas producers, of storage batteries or of aeroplanes. I

was trained looking backwards into the past. I was not trained for what was ahead of me.

There was never a period since the world began when man had so rapidly to abandon the practices of the past and to put his trust in what his father and mother knew nothing about.

The changes in the last fifty years have therefore scrapped most of the technical experiences of the past and have profoundly modified moral obligations.

Our parental training, our religious training, our school training and our social training have been governed by the ideals of the routine past. Although progress absolutely depended on initiative and to a very small extent on routine, we have not been equipped morally, mentally or physically to do good original work.

Much of Socialism, for instance, rests on the assumption that the good things in the universe are strictly limited in quantity and if any man has more than the average he must have robbed somebody else. The same assumption underlies the aspiration for suffrage by women. If anything was ever a routine survival from the foolish past it is the idea that suffrage is a panacea. I would give suffrage to those who want it, as I would give away a worn-out garment. Far more important than suffrage is the realization that the home, the school, the church and the ball-room, where men and women work side by side, are cleaner and more efficient than businesses managed by men alone.

The good things in the universe are not limited. The telescope shows that there are billions of suns in reserve, most of them larger and finer than our sun. We have reached out with our nerves of sight and rescued these suns from the bottomless void. We may in time harness their heat for our service, even as we now make the oscillations of the ether carry our messages. Grand opera is no longer limited to the rich, nor moving scenes in distant lands to bold travelers. The phonograph, even making alive the voices of the dead, brings into the lone, cold, winter camp in Northern Alaska

a wealth of music which twenty years ago no emperor could have commanded. A tramp, for the price of a beer, can sit in comfortable, cool and restful darkness, watching living scenes out of the long ago, scenes that not even the greatest traveler could formerly have witnessed.

It is not true that the few are growing richer because they are impoverishing the many.

It is true that our greatest men, the men to whom on account of their initiative we owe most, were not trained to use their great gifts. They received a routine education, and as they found it of no use, like children who have found a box of matches, they did not know how to use the blessing of fire.

The old rules of the road, the turning to the right, the halt at grade crossings to look and to listen, the speed limit of six to eight miles an hour, cannot be applied to aeroplanes, yet we have tried to keep our Rockefellers, our Carnegies, our Harrimans, our Hills, within routine bounds. We have not even advanced to the state of using modern devices. We are still teaching our children to read fairy tales instead of watching moving pictures; we teach them to write instead of training them on typewriters; we painfully drill into them multiplication tables instead of initiating them into the mysteries of the slide rule; we teach them to add and subtract instead of drilling them on comptometers; we teach them to draw instead of carefully training them to use photography; we have them drum for years on the piano even if they have no musical ability, when they ought to be trained to put a soul into mechanical records.

What is the fault of the whole educational system? As is always the case, when routine is placed above initiative, we are relying on methods and devices and systems instead of on principles; we codify our laws and add countless new ones instead of branding every one of us with the fundamentals. So absolutely unprepared are we by past training and teaching that we would have great difficulty in agreeing as to what the fundamentals are. The need of the age is clearly

to see and practice, not a Christian era conception, nor a Crusade conception, not a Reformation conception, not an American revolution conception, but a twenty-first century conception of the golden rule, of ethical ideals worthy of the telephone, wireless, gas engines, aeroplanes and radium. The new era must produce a new man. Will he prove a Frankenstein?

I have no right to assume that I can see further into the starry night ahead than any other on the lookout, but it seems to me that what we most need is to come to some understanding of the relative responsibilities of individual, of corporation and of state.

The collective average is always weaker than the best units. The average duration of human life is determined by a means in which the shortest has as much weight as the longest. The average wisdom of government is the mean between the fool and the wise man. The way to better man in the aggregate is not to lessen the responsibility of each unit, but to increase it; to bring, from within, the poorest units up to the level of the present best and to have the present best establish a higher standard.

What is the particular application to engineering schools?

Engineers more than any others ought to be able to appreciate the value of initiative. The courses in the engineering schools ought to be modified so as to develop initiative. Engineering students ought to be taught to distrust all the traditions of the past. The engineering teacher ought to warn away from anything that has already been tried out. The assumption ought always to be that "what is" is probably wrong, and the absurdities of "what is," for instance, a locomotive engineer on the tail end of the engine, ought to be unmercifully pilloried. The student ought to be taught to guide himself, not by landfalls and landmarks, but by the eternal stars. It can be done and it is the duty of teachers of engineering to do it.

EDUCATION AND EFFICIENT LIVING.

BY MEYER BLOOMFIELD,

Director of the Vocation Bureau, Boston, Mass.

Mankind has passed through various "ages," picturesquely described by the historian as the ages of steam, of iron, of steel, of electricity. But all indications, all the signs of the day in which we find ourselves, the industrial unrest, the changes in our legal and political institutions, the acid test of organized enterprise through scientific management, and the transformation of our educational policies, point to an age which transcends in value all the historic ages preceding—*the age of man*—that period in which society sets out to discover how the energies of men can be liberated for the most effective living, livelihood, and social service.

To the engineer and to the methods of our technical schools the social reformer and the progressive educator owe a larger debt than is generally recognized. The antiquated idea of education as the privilege of a fortunate few, enjoyed for the most part in a cloistered aloofness from the problems of common life, has been fast crumbling away under insistent modern demands for democratic training of "all the children of all the people"; demands arising not only because of the necessity for civic self-preservation, but also because a truer understanding of human capacities makes us all impatient with the present waste of gifts, talents, and human possibilities.

We have been so busy trying to catch up with our tasks of spreading the common schools, lessening illiteracy, and promoting good citizenship, that we could not pause long enough to consider differences in human nature and the fundamental importance of differentiating our approach to each individual. In times of stress and emergency we do not inquire too closely into personal merits. All must be dealt with alike, all who

seek must be supplied. When normal conditions are restored, however, more scientific methods must be followed or the resulting harm may far outweigh the good. So with our schools. As the basic need for the elementary instruction of the masses in elementary subjects is met (and there is yet much to be done in this country) then stock-taking and a scrutiny of methods and accomplishments become a part of intelligent administration. During the extension of popular opportunities for schooling, for several decades past, there have developed the modern schools of applied science and the specialization in the engineering branches. No greater contribution to educational progress has come during this period than in the lesson, taught by these schools, of the value of the laboratory and of contact by the student with things as well as with ideas. "How can a man learn to know himself?" asked Goethe. "Never by thinking, but by doing."

Two purposes mark any intelligent system of training men; first, to enable men to know themselves, and, second, to enable them to find themselves. Schooling of the conventional kind leaves out most of the senses in the training scheme; it is devised for inert masses of pupils; its tools are printer's ink and the teacher's voice. President Eliot has pointed out the defect in making our schools for "listening."

This is surely a stock-taking period in business, in politics, in education. The employer has been complaining of the product of the public school. We find that nearly half the school children of the land drop out before they even complete the grammar grades. We find, too, that our system of secondary education, admirable though it is in many respects, is ministering mostly to the four per cent. or so of its pupils who go to college, and has scarcely faced the life-work needs of the vast majority who must go to work. This dropping out of school, therefore, of so many unprepared boys and girls at a time when they should be laying the foundations of vocational efficiency, is now recognized as a national calamity. Many thorough investigations, one by the United States Bureau of Labor, have shown that pressure of circumstances

accounts for only about one third of this exodus from school to work. Two thirds could have remained to further fit themselves if opportunity and intelligent organization could have been provided.

The abrupt ending of school influence for so many on the fourteenth birthday is only one of a train of evils. Dropping out as they do, their entrance into working life is no less deplorable. They do not know anything about the work they go into and they leave one job for another, just as they left school. Few have any idea of preparing themselves for a career. They drift until manhood responsibilities are upon them; then it is too late to prepare for anything. It is now known that a large part of the misemployment and unemployment problems can be traced to these early blind driftings in the uncharted employments. The school has failed to connect with the vocational needs of its pupils, has failed to take into account the probable careers and experiences of most of its children. On the other hand, the kind of work these young people go into is not of a sort to develop them, to train them, or make anything out of them. Therefore both school and job are now up for investigation. President Eliot has spoken of the "life-career motive" in education. Any education which fails to build on this most fundamental purpose, or fails to arouse an interest in it, does not belong to our militant age of effort and service. Any occupation which does not deepen and enlarge this purpose and motive, which does not in some way offer both a life and a career, is one which probably needs the attention of public opinion and the legislature.

School and work, then, must minister to the life-career motive, to the bread-winning effectiveness of our workers and citizens. The movement for vocational guidance has grown out of a deep recognition of the price society pays for the aimless driftings, the economic waste, and the social wreckage attributable to the unbridged chasm between school and work, to the unprotected and unguided transition from school life to working life. Vocational guidance looks upon both school and shop as means for investing the capacities of the young people

to their own and society's utmost good. Investment, not exploitation, is the goal. The child's good, and the community's good must be placed above all else.

Experience has demonstrated that where a school looks intelligently to the life-career there is hardly any dropping-out problem. The employer, who fulfills his responsibility, reduces his losses, which in many an establishment amounts to a turn-over of employees every four or five years. If education does not lead to self-discovery, what else does it do? In this desideratum the technical schools have been quite fortunate. They have greatly aided their students to find themselves. Are they all living up to their opportunities and their privileges? There is no little danger of complacency and backsliding on their part. Let me say that vocational training does not in itself carry any guarantee that it will not deteriorate into abstractions and academic routine, that it will not lose touch with reality. With the doors of our technical-training schools wide open, as they should be, there is no assurance that fitness alone will seek admission. Mass instruction here, as in the academic schools, is prevalent. The time for "hand-picked engineers" as a professor in one of our technical schools has phrased it, has gone by. Never was greater need than now to formulate standards and to organize a selective process for the future engineers. This plea is made not so much for the benefit of the schools and the profession, as for the young men who may be misled into wasting years on preparation for pursuits for which they are not fitted and in which they never can be happy.

The student of the vocations marvels at the unbusinesslike hiring of men in various establishments. The employment manager is supposed to be the mind-reader and fortune-teller of the firm. If his guesses turn out well he holds on to his place. How many firms can you recall which have drawn up specifications of what they need in the way of employees, drawn up their requirements so definitely as to exclude automatically those who cannot succeed? "Trial and error" is the prevailing method, with all the waste and discouragement this involves to all parties concerned.

I have not observed that the engineering callings have framed their demands so that parent, teacher, and prospective applicant can base a choice of occupation on the data set forth. Nor have I found a surplus of accessible, vital information concerning the new and most promising developments in the engineering pursuits, chosen to direct attention to the less crowded departments. Many of us believe that the engineer, the technically-trained man, will more and more rank with the most socially-advanced agencies for the promotion of human welfare, with the practitioner in preventive medicine and the trained philanthropic agent. We have only to look over the contributions to public health, comfort and efficiency, made by our institutions of applied science during the half century just passed, to realize that what has been accomplished for public sanitation, protection of the milk, water, and food supply, factory hygiene, ventilation of public buildings, and elimination of polluting wastes is only prophetic of what is yet to come. Indeed already from the field of the efficiency engineer has come, perhaps, the most important message since machinery came to do man's work, since the factory system replaced the home as a producing center. Messrs. Taylor, Gilbreth, Brandies, and others have made the nation think. And in the field of efficiency engineering I find an analogy for what vocational guidance regards as the true function of the school and of education. The teachers are the functional foremen, the courses of study are the planned and routed tasks. The aim of all these forces should be to produce an individual equipped for the scientific management of all his endowments and resources; whose faculties are organized for economy of effort in reaching results, ease in exertion, persistence in traveling toward the set goal, and vision to understand his relationship to his fellows.

THE TEACHING OF SCIENTIFIC MANAGEMENT IN ENGINEERING SCHOOLS.

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Two problems confronted the writer of this paper when he began his work:

First, to take the engineering school as it commonly exists today and use its equipment effectively in the creation of a practicable course for men who desire to follow the profession of industrial or management engineers.

Second, to take the student as he is and to equip him well for his work, giving him studies which will be of real value and which he cannot as well acquire in the shop afterwards as in the engineering school.

It is merely good management to use all the facilities which now exist in the engineering schools. Their regular courses are, in my belief, admirably adapted to their purposes and admirably conducted as a general thing. I propose to use those courses in the training of the industrial engineers so far as possible. There is room in scientific management for the man trained in every type of engineering. I propose that the student of the science of management shall take three years out of four in some one of the regular courses in engineering, devoting one year's work, made up of half the work of the junior year and half the work of the senior year, to the direct courses in scientific management and to their allied courses. The allied required courses are often given in engineering schools, and are almost always given in the colleges of arts, which commonly exist combined with engineering schools. The direct courses advised here are given in the form proposed, so far as I know, in no engineering school, and amount to four half courses. The progress of the work, as will be noted later, requires that the work in scientific management shall be begun in the junior year. I believe that the plan outlined here is practicable and will enable an engineering

school to make the best use of its present equipment in the training of the industrial engineer. I believe that all the content of these courses can be much better acquired in the engineering school than in the shop after graduation.

The American undergraduate today, both in the college and in the technical school, appears to me marked by a most profound ignorance of industrial conditions, both in general and in detail. Whether that condition comes from modern city life or not it is not the province of this paper to discuss. All the evidence at my disposal goes to show that it exists. I do not believe that any lecture course can conquer that ignorance, for I do not believe that the average student has any basic knowledge, apperceptive basis, if you will, on which to build the theory of the science of management. For that reason I should prefer to make it a prerequisite to the junior and senior courses in industrial engineering that the student electing these courses should be required to spend the sophomore and junior vacations in the shop. I should assign more hours a week to shop or laboratory work than to lecture and recitation, but not more laboratory periods.

It is partly because of the undergraduate's ignorance of industrial conditions and partly because the opportunities of the shop to give training in the science of management are limited, that I state my firm belief that a man trained for four years by the plan outlined here will be far better equipped to handle industrial problems than a man graduating from one of the regular courses who attempts to obtain his knowledge of the science of management in the shop. I had believed that the basic theory of the technical school, namely, that the student could advance far more rapidly in the school than in the shop, had been settled long since. It is on that basic educational theory that I propose the training of the industrial engineer in the engineering school, yet to my surprise I find some engineers proposing to make shop training alone serve the special needs of the industrial engineer, thus proposing a theory which is quite outworn for the other branches of engineering. Shop and school are too firmly welded today to allow either to stand alone.

As regards the question of whether it might not prove wise to give one or two extra years to the training of the industrial engineer, I have expressly excluded this proposition from my paper, as I have limited myself to the discussion of the engineering school as it is. I, therefore, took the four year course as my basis.

With the assumption that the work of the student of scientific management during the first two years will be the same as that of the student in one of the existing engineering courses and with the assumption that the student has spent his sophomore vacation in the shop, suppose we start the student selecting scientific management, at the beginning of his junior year and discuss the direct and allied courses in scientific management which he will take in the two years before graduation. That brings us directly to the question of what powers and what information should be given the student of this subject. As regards the powers the best way that I know to obtain some statement of those is to turn to the powers possessed by successful industrial engineers of my acquaintance.

According to my analysis the essential powers possessed by those successful engineers are the following:

First, the power of using the work done by other men. That power saves a man from repeating uselessly work done before, saves him from repeating the mistakes of others and enables him to build on the foundation of the best work already done.

Second, the power of perspective, of adjustment to environment, of seeing the proper relation which a process bears to the other processes in a plant, or that a plant bears to its industry as a whole.

Third, the power of research, of so collecting, correlating and translating masses of facts as to obtain their meaning.

Fourth, the power of the making of designs and the carrying out of construction in the basis of the facts obtained by research.

Fifth, the power of expression, gained largely through the study of English, which makes both research and construc-

tion so intelligible and useful that no time is wasted through unintelligibility.

After powers comes information or perhaps it would be better to say that powers and information combined bring us to courses allied and direct. The first allied course that I should require of the student is economics. The industrial engineer must work with both men and machines. It is his task to produce, to bring order out of industrial disorder, and the history of economic advance, as well as the advances of present day economic research, must be placed before him if he is not to waste time in repeating needlessly the economic mistakes of the past. The industrial engineer must have the light of economics upon his work. He must be able to use intelligently the new work in economics, but it must never be forgotten that he is personally a scientist, not an economist; that, to use Ely's phrase, he is to deal mainly with natural rather than descriptive science.

So much for the necessity of the work in economics to which I have assigned a course and a half. Two full courses have been assigned to those courses which aid the industrial engineer to understand the physical and mental condition of the worker, one year of physiology, hygiene and sanitation and one year of psychology, including experimental psychology. I believe that no single factor is to take more commanding place in the development of the next years in scientific management than the work to prevent the evil effects of the old type of management, of speeding up, of rush work and of disagreeable and dangerous processes. The effect of industry on the human frame and the human mind, the replacing of false theory with scientifically determined facts as regards the physical and mental condition of the worker, will be a part of the work of every industrial engineer. The graduate in this course must not only have acquaintance with the present state of knowledge in the subjects specified, he must be able to use the advances of knowledge obtained by the sanitarian and the psychologist.

Of the necessity for a half course in the theory and practice

of accounting it is perhaps merely necessary to speak of the necessity for the industrial engineer to have a thorough knowledge of costs and of their relation to the books of the regular accounting system. The industrial engineer must, in the last analysis, have his eye constantly upon costs, for in no profession is it more necessary not to have the work done cost more than it is worth. Summarizing the allied courses we find that the list is as follows: One year and a half of economics; one year of physiology, hygiene and sanitation; one year of psychology including experimental psychology; one half year of the theory and practise of accounting. I assume that equal amounts of lecture and recitation time are allotted to each full course, so that Scientific Management 1 A and 1 B for example, would use the same number of lecture and recitation hours as Economics 1. The laboratory hours required for the Scientific Management courses would be additional to this.

As regards the content of the allied courses proposed here, it seems to me that the conditions existent in different institutions vary so greatly as to make it impossible at present to advise specifically the ground that these courses should cover. In each case the relations between the direct and allied courses must be determined by the cooperation of the men in charge of the work, and the content of the allied courses will be affected by those relations. I advise specifically here as regards the content of the courses in Scientific Management, but I feel that the welding of these courses with those now existent is an individual problem which each institution should solve for itself.

Turning directly from the allied courses to the direct courses in the science of management we find that these courses divide naturally into four half courses. Scientific Management 1 A, the first, is intended to give the student a general view of industry and of the principles of scientific management. Scientific Management 1 B considers the problems presented in the planning of work and of all operations preceding the actual shop operations. It lays especial stress

upon the lesson to be taught throughout, namely, that scientific management is a science to be solved by scientific methods. Scientific Management 2 A takes up the problems of work in the shop with especial reference to the workman and his machine. Scientific Management 2 B considers the results of the work done in 1 A, 1 B and 2 A, and takes up problems of costs, of purchasing and of sales and especially considers the scientific determination of the policy of a business.

Each of these courses is aimed to meet certain definite needs or to furnish certain necessary information. Summarizing these needs in the case of Scientific Management 1 A we may say that this course is designed

1. To meet the ignorance of the student concerning industry and to give him some understanding of the flow of work. To give him some understanding of the principles of the science of management and of general methods of the scientific attack of industrial problems.

2. To make him realize the main common factors in industry.

3. To make him realize the main differing factors which make every plant in every industry a new problem.

4. To show him the methods of statistical research by which laws and principles are determined.

5. To train him in observation, to enable him to separate process from process and function from function.

6. To give him actual examples of the application of other sciences to the problems of management.

To accomplish the purposes just laid down I propose that the student in this course shall make an examination of four industries, taking one representative plant from each industry, and that he shall examine every step in the flow of work from the first inquiry of the customer to the final settlement of the account, examining these steps broadly without going into their details. To put it another way I propose that the student in this course shall study the broad divisions of four plants in actual operation, leaving the study of the subdivisions to follow in the next three courses. Together with this

examination of actual conditions I propose that the student shall examine those factors common to all the industries and the factors which are different in each industry.

Few things are more important in the very beginning of the student's work than to have him see that a system built for a given plant and working admirably for that plant will not apply in another plant as it stands, for the simple reason that the different factors in the second plant require study before the systems involving these new factors can be designed or constructed. It is most essential at the very start to make the student realize that he must rely on science and not on a previously obtained mechanism to solve the problems of each new case, that he must solve his problems by the use of the principles of scientific management and not by the application of any ironclad system. That lesson once learned opens the road to the proper study of the principles of the science of management and of the methods used by that science. These methods are, of course, practically those used by every other science, yet one part of them, the methods of statistical research, the proper translation of masses of statistics, the obtaining of the significant figures, if you will, needs more emphasis in the case of the student of industrial engineering than would normally be required of students in most of the other engineering courses. Our knowledge of methods of statistical research is increasing daily. They offer too valuable a tool for the industrial engineer for them to be omitted from a course in scientific management.

In this connection it is important for the student to learn that the mere accumulation and even the correlation of data may have no value and may be an extremely expensive habit, provided judgment is not used in the selection of the data to be studied and provided the data, once assembled and correlated, is not rightly translated into usable form. Few things need the control of common sense more than statistical research. Few things are more valuable, once that control is exercised. Work in graphical analysis should prove of assistance here.

It is extremely necessary in a course such as is here outlined that the student should be required to test and retest his knowledge. No student should be allowed to complete this course without handing in a report showing a careful study of the main processes in some plant in actual operation, preferably a plant engaged in some industry not studied in the four industries chosen for the course.

Having gained his perspective in the first course in scientific management the student may begin the study of detail in the second course in which, as has already been said, it seems advisable to consider the planning and preparation processes which occur previous to the passage of the work into the shop. This course involves the detailed study of a group of the main factors involved in management, routing, stores, etc., determining the subdivisions of these factors for individual cases but excluding direct machine operations. Methods of collecting all available data concerning these factors of industry, the making of a science out of the operations of an industry through the collection, correlating and expression in useful form of all data concerning an operation should be shown here with especial reference to the working out of the first principle of scientific management as given by Dr. Taylor. Mechanisms derived from scientific study and already in use in different places should be considered and basic likenesses in these mechanisms discussed. Differences, existing in different industries, should be considered and it should be made plain that these mechanisms, being based on scientific study of principles, will differ outwardly in different cases but will be basically the same.

The fact that men and machines, and not machines alone, are studied in the science of management must be brought out here in connection with physiology, hygiene and sanitation. The effect of heat, light and air on the workman, the problems of fatigue and the deleterious effect of the rush work of the old type of management should be especially considered here.

The student in this course should not go back of the point

where the orders are transmitted from the sales department into the factory, but his study of the preliminary processes should begin at this point, pass through the study of design, of preparation of material or stores, through study of the principles of stores, through routing, order of work and the control of work going through the shop, and should include some symbolization and some studies of the general articulation and functionalization of the planning department. Study of the problems of tools, of time study and of instruction cards, although technically perhaps included in this division of the subject, should be left until the following course.

When the student has completed the course outlined above he should have a fair knowledge of the best practice of industrial engineering in its relation to the planning of work. He should have a fair conception of the methods of attack by which industrial difficulties have been solved and the way in which they may be solved by the application of the science of management. He should himself have gained some power in the solution of practical problems and he should be required at the end of this course to prove his ability by the actual solution of an actual problem of the planning room.

Scientific Management 2 A purposes to take up the problem of the passage of work through the shop from the beginning of the first machine or hand process applied to the raw material to the delivery of the finished article to stores or to the shipping room. It involves a study of machine and hand processes but this is but a part of its work. It is in this course that the student first meets the great problem of the task, of the substitution of the justice of science for the guesswork of man as a basis for the coöperation of employer and employee, and meets the problems of education that are involved in the theory of functional foremanship.

We may outline briefly the subject matter of the course as follows:

1. Study of the task with a view to the elimination of all disagreeable and dangerous elements.

2. Study of the task with a view to determining the duties of the management in obtaining the right task.

3. Study of the task with a view to machine improvements. (These studies should be done in the shops of the school.)

4. Study of the education of the workman.

5. Study of functionalization in the shop.

6. Proper methods of instruction card writing.

7. Proper methods of record.

The following subjects should also be considered here:

8. The selection of the workman.

9. The study of physiological and psychological factors involved in certain given cases.

The student who gains what he should from the course in Scientific Management 2 A should gain far more than the technique of time study. He should make appreciable gains in his power of observation and of analysis. He should gain the conception that time study, far from being a weapon to wrongly speed up a worker, furnishes a means of removing the disagreeable, inefficient and dangerous elements of a worker's task. He should gain facility of expression in the practice of making out instruction cards, improve his power of choice in the selection of tools for tool lists, and gain a considerable appreciation of the best methods in vogue to-day for the increase of the efficiency of men and machines.

No part of his work should give the student more understanding of the problem of obtaining the workman's coöperation than his study, towards the end of this course, of the problems of the scientific selection and development of the workman as laid down in the second and third of Dr. Taylor's principles of scientific management. The year's work in physiology, hygiene and sanitation which has preceded this course, the work in psychology which goes on with it, should be of great aid to the student in his effort to comprehend these most important principles.

At the end of this course, the student should present a report of a rather comprehensive nature involving the determination and expression of a task. This report should involve not only time studies, but all the expression of the task as shown in the writing of instruction cards, tool lists, work of

functional foremen, etc. The work in English should show its value here.

Scientific Management 2 B, the final course, considers the results and records of planning and of work in the shop. It should consider the effect upon design of the records made in both of the previous courses and especially the effect upon the policy of the firm of the weak and strong points brought out by the scientific study of the various problems involved. The latter part of the course should be given up to a general review of the whole subject and should give especial consideration to the fourth of Dr. Taylor's principles of scientific management, the new division of the total burden between management and operative, as shown in all the courses.

Summarizing the general subject matter of this course we may say that this fourth section should concern itself, first, with the proper recording of the work done in respect to time and to costs; second, with methods of wage and bonus determination; third, with methods of inventory taking and purchasing curves; fourth, with methods of design in scientific management; fifth, with a general review. Then, as determining future policy, should come the study of sales curves and cost curves, those great aids in determining what classes of business really pay.

The wide-reaching possibilities of using the investigations of scientific management in determining the policy of a business, in respect to design, to classes of product, to choice of customers, and to determining the field of sales has received as yet but little outside notice. Of the two functions of cost, one, the use of costs in determining prices, has received a fair share of attention. The other, the use of costs in determining the most profitable classes of business, receives to-day nothing like the attention that it merits. The work in costs should not only teach the student methods of cost distribution which will distribute every penny expended in a given time upon the product manufactured in that time. It should teach him also to use costs as a constant check upon the progress of his own work and as a guide to the future direction of a business.

Sales curves added to cost curves throw still more light upon the problems of the most favorable fields to attack and the classes of goods which seem best suited to both the production possibilities of the factory and the requirements of the customers. In a great number of the factories of the United States to-day the sales and the manufacturing departments live in a state of warfare. Service is pitted constantly against production. It is peculiarly the province of the industrial engineer to determine by study the actual basis on which the most profitable service and production can be given and to bring the sales department and the factory into harmony.

The problems of the maximum and minimum quantities to be carried in stores requires careful study if a plant is to avoid the two extremes of being out of material or of locking up too much money in stores. Both extremes are dangerous and both should be avoided by scientific study and not by guesswork. Work of this sort begun earlier may be amplified in course 2 B.

The application of these investigations to design, governed largely by the charted studies of time and costs, has produced remarkable results both in the adaptation of design to the needs of the customer and consumer and in the cutting down of the costs of the article. The final course, Course 2 B, is the place for the discussion of these points.

At the end of the course the student should make a report embodying actual reports of time and cost, of sales and purchasing curves for a given plant.

As regards the methods of instruction, lecture, recitation and laboratory are all mingled in about the usual proportions. The laboratory work must largely be done in allied friendly plants, but the present day interest of manufacturers in technical education should make this easily possible. No task setting should, however, be done elsewhere than in the shops of the school. That is too delicate a matter for student hands and involves too many possible difficulties when done by other than experts.

I left teaching behind me a considerable time ago when I

took up the study and practice of the science of management, but I believe I have not lost any of my interest in effective teaching or any of my beliefs in education. This paper is the outcome of my interests and beliefs in education and in scientific management. And I believe in scientific management because in the period during which it has been my good fortune to have been associated with Frederick Winslow Taylor, I have never found any industrial problem which the science of management would not solve. I have seen with my own eyes marked savings in money, marked advances in service and production, marked improvement in the condition of the worker. With that personal experience it is perhaps no wonder that I have become an enthusiast on the subject, that I look for its advancement in every way and that the teaching of scientific management should interest me deeply.

I believe that with the training outlined above, properly given by qualified men and properly assimilated by the pupil, the student should reach the end of his course a thorough believer in the science of management, with the desire and ability to use the scientific spirit in the solution of the problems of industry. He should have a mind that is willing to accept and use all that is best of the work of other men, yet he should be constant in the pursuit of knowledge. The industrial engineer will never be a man who "knows his own business" for he knows that no man can measure or limit the advance of science. Free from dogma and from prejudice, blessed with the open mind and with the equipment of modern science the industrial engineer, so trained, should be prepared to do his part in bringing justice and betterment to every worker everywhere in the new industrial day.

Note.—In the preceding paper I recognize that I present the view of one man, aided by friendly criticisms. The development of a course of the kind proposed here must be, in the last analysis, the work of many men. It has been my aim throughout this paper to make definite statements which can be definitely shown to be practicable or impracticable in a given case. Deeply interested in the problem as I am, I shall welcome all constructive criticism.

A BROADENED VIEW OF EFFICIENCY IN ENGINEERING INSTRUCTION.

BY LEWIS J. JOHNSON,

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I certainly favor efficiency in engineering instruction as well as in other things. I believe that we owe a great debt already to Mr. Taylor, Mr. Gilbreth and the rest for what they have done to wake us up and show us the way on these lines. Particularly do I rejoice that Messrs. Taylor and Gilbreth recognize as indispensable the cultivation of good will between employer and employee by simply making it automatic by honest and intelligent efforts for just and fair relations. They see the moral and human side, hence I believe that they are in a fair way to lead us to success.

But to my mind efficiency is a pretty broad subject, broader than mere questions of economical production and transportation. It involves to my mind to an equally high degree the correct distribution of emphasis and attention. This, to my way of thinking, means a high degree of emphasis and attention upon the basic, but sadly neglected (when not misdirected, perverted, or sterilized) lines of activity, political economy and the science of government.

For while, of course, it profits us much to extend our already *relatively* efficient means of production, our work will fall far short of its purpose if we do not do something to put our whole industrial and political structure on a firmer basis through getting in line with the fundamental laws of justice and human nature. If this be done, I feel confident that progress toward self-sustaining industrial order and peace will be not only possible but rapid and certain. Otherwise our present chaotic conditions can hardly fail to grow worse. The "conservative," as he loves to call himself, who

seeks quiet and peace by sitting on the social safety-valve, and his compeer in social value, the man who seeks to secure relief for bad conditions by putting grit in the bearings of his employer's machinery, are both abroad in the world. The normal man must begin to put efficiency into his citizenship if we are to find the true way out.

No one, whether lawyer, clergyman, journalist, office-seeker, office-holder or the ordinary academic essayist, is so well equipped, I believe, to deal with this great field of scientific management fundamentally and constructively as the man with the engineer's or the applied science man's training and attitude of mind. If we are to have a society in which securely to practice the fine and noble art of scientific management in the production of wealth, the scientific rather than the traditional point of view must, in my opinion, get into effect in our biggest and most far-reaching public relations.

Our customary habit of thought in business and commercial relations is still nearly as greedy, because as misguided, as in the time of the Pharaohs. Our political machinery, even in this land of progress, has been but little improved since the invention of the steam-engine. Here I believe is an immense and most promising field for scientific management.

As a first step we should seek and establish a true and sane definition of property. For thus only can the property of the capitalist and of the laborer be secure and a proper economic incentive (and that means a chance for industrial peace) be maintained. This I believe is no insoluble task even if it is largely abandoned for the consideration of far less important matters. In the political field scientific management would set in motion the old ideas expressed in the Bills of Rights of the early state constitutions. These were particularly well stated a century and a third ago in the Massachusetts Bill of Rights; well stated, but for reasons then unavoidable, imperfectly set in motion.

This subject I venture to bring before the society at this time because here is a body whose instincts and habits are

fundamental and constructive—who will quickly see, if they do not already see, that, important as scientific management of the production of wealth certainly is, a scientific management of the distribution of wealth and the maintenance or establishment, if necessary, of peace, contentment and order in society is even more important, and that it is both their right and duty as citizens to do their full share in this work, and perhaps to take the lead.

I think that engineers, if no one else, will dare believe that the distribution of wealth in society can be made as automatic, smooth-working, and satisfactory as the circulation of blood in a healthy animal; that they will realize that such results can come only from proper guidance of natural forces, and not from arbitrary and shallow legislative interference with such forces. I certainly believe that we have only to get in line with the fundamental laws of economics and human nature, and let them, like gravity taking water down hill, do the work. And we need not feel concerned if the school of thought which got humanity into its present and century-old fix, denies the existence of such laws or the possibility of getting into harmony with them.

The work of the next few decades is a new work, a work for applied science men and others who can comprehend that there can be no social or industrial peace so long as human traditions, conventions and laws are kept flying in the face of the fundamental laws of the nature of men and things. Nothing is so much needed by engineers and applied science men as a realization of this point of view. It opens to them a vastly broadened prospect of service as citizens and, in common with all other useful workers, greatly heightened satisfactions of the durable sort, to use President Eliot's admirable phrase. Hence nothing can contribute so much to the efficiency of engineering instruction in the biggest and broadest sense as to make clear to the young engineer-citizens that their training in careful and responsible construction can apply and ought to be made to apply to the whole range of civic and industrial problems; and that they need feel neither surprised nor dis-

turbed if popularly accepted "experts," apologists for existing evils, oppose their conclusions. George Stephenson had to struggle hard in the face of the "experts" to get recognition for his "travelling engine," and the responsibilities and opportunities of the civic engineer of to-day are perhaps greater than those which confronted the mechanical engineer, George Stephenson.

THE APPLICATION OF SCIENTIFIC MANAGEMENT TO THE OPERATION OF COLLEGES.

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Manufacturers and business men often look upon their own undertakings as peculiarly different from every other apparently similar business. It will not be surprising that every college may feel that it has problems unlike any other, and of greater difficulty. Naturally, the men connected with the colleges and universities look upon their duties as something entirely distinct and apart from those which occupy the attention of people in other walks of life. Yet, as a matter of fact, these problems are very much alike.

A college is a big business enterprise. Its product is the attainment of high ideals in scholarship, in character development and culture, and the preparation of youth for the activities of life and for intellectual and spiritual leadership. In place of mechanical output, its product is men. But the element of cost enters in just as much as in any other business enterprise, that is, we want to get as much as possible for the money. We cannot always measure the value of the output in dollars and cents, yet every one likes to feel that the money which he contributes to educational and philanthropic purposes is well expended, and future benefactions often depend on showing a high efficiency.

One of the points that show the need of Scientific Management is that many institutions have difficulty in running on their endowment income and tuition fees, and find themselves constantly face to face with a deficit or at least hampered in the extensions and expansions they would like to make. It may well be that a critical examination of the expenditures and methods of some of our colleges may be more helpful to

them than more money. Again, the professors complain that so much of their time is taken up by correcting examinations and assigning marks, and maintaining records, petty details, deadening routine, that they have not the freshness and the buoyancy of intellect that leads to creative thought, to advancement along the lines of research.

In his report to the Carnegie Foundation, Mr. Morris Llewellyn Cooke has stated "A further increase in the efficiency of the teaching staff will be obtained through such specializing as will come as the result of functional management. There are some things that are clear. During the interviews which the writer had with college professors, he found them spending time in taking inventories, keeping track of appropriations, mimeographing examination papers, and handling routine correspondence. These things are clerical work, and should be handled outside the teaching field, and not as a part of the teacher's duties. In addition, there are many other things, including management of the buildings, which might easily be centralized and done better by officials who can devote their time exclusively to them. Such changes would leave the professor more time for the work for which he is especially fitted."

"The manifold duties carried on by the college professor seem overwhelming. I saw a single individual personally assume the direction of a large building including laboratories, machine shops, power plants; maintain order and discipline among seven hundred at times boisterous spirits; direct and inspire a teaching force of a score of rather unusually able men; and keep in touch with a large body of graduates. The college professor does not realize how many distinct functions he performs. The high-priced presidents of our railways, banks and steel companies would not dream of performing this variety of functions. They would refuse to do so because they know they could not do them well."

"This part of raising the efficiency of the college professor will have to be done by building up central agencies for doing much of the work he does now, and for doing it so much better

than he possibly can, that he will be glad to relinquish his responsibilities in these respects."

In contrast with the commercial and industrial world, there will be found a general lack of intensiveness and snap everywhere pervading the universities and colleges. There is no haste in attending recitations and plenty of time and leisure to discuss matters with those met on the way. The professor is occasionally five or ten minutes tardy in meeting his class. If the young man is to succeed later in life, he must realize the necessity of intensive application to his work during that time when he is assigned tasks; he must realize that an hour of his time is a valuable thing and cannot be carelessly wasted.

In an address before the University of Pennsylvania, Dr. Taylor, referring to graduates of technical schools, said "Why is it that these young men are discontented and of practically little use during the first year or two after graduating? To a certain extent, this is unquestionably due to the sudden and radical change from years spent as boys, almost solely in absorbing and assimilating knowledge for their own benefit, to their new occupation of giving out and using what they have for the benefit of others. To a degree, it is the sponge objecting to the pressure of the hand which uses it. To a greater degree, however, I believe this trouble to be due to the lack of discipline and to the lack of direct, earnest and logical purpose, which accompanies to a large extent modern university life."

"As to college discipline, it cannot be good training for after life for a young man deliberately to be told by the university authorities that he can flagrantly neglect his duties sixty times in one term before any attention will be paid to it, while, if in business, the same young man would be discharged for being absent two or three times without permission. The boy who joins the football squad is given no sixty cuts a season, nor is he allowed to choose what he will do. He does just what some one else tells him to do, and does it at the time and in the manner he is told and one or

two lapses from training rules are sufficient cause for expulsion from the team."

"I believe it is possible to so train young men that they will be useful to their employers almost from the day that they leave college, so that they will be reasonably satisfied with their new work, instead of discontented, and to place them upon graduating one or two years nearer success than they now are; and this can best be accomplished by giving them an earnest purpose through six months' contact early in their college life with men working for a living; by rigidly prescribing a course of studies carefully and logically selected, and with some definite object in view, and by subjecting them to a discipline comparable with that adopted by the rest of the world."

"Of all the habits and principles which make for success in a young man, the most useful is the determination to do and to do right all of those things which come his way each day, whether they are agreeable or disagreeable."

"Is not the true object of all education that of training boys to be successful men? I mean men successful in the broadest sense, not merely successful money-getters, successful first in developing their own characters, and second, in doing their full share of the world's work."

The need of scientific management is further shown by the limited use of the rooms in college buildings. As an instance, it is reported that the president of the University of Wisconsin conducted an investigation of one of the main buildings of his institution, and found that the rooms in it devoted to teaching were used, on an average, only three hours a day. This is about the average amount of use in many instances in several other universities and colleges. The proper assignment and utilization of the rooms during the year would double the capacity of the college buildings.

In illustration of the point of using, or not using, the same room for different purposes, Mr. Cooke has described two large lecture rooms. "One of them at the Massachusetts Institute of Technology was reserved for a lecture which took place

six mornings in the week at eleven o'clock. Owing to the fact that the room was made more or less a storehouse for physics apparatus, it was rarely allowed to be used for any other purpose. On the other hand, at the University of Toronto, the far-sighted professor in charge of the department had seen to it that in the construction of his lecture table every wire and pipe had a connection both above and below the floor, so that on an hour's notice it could be removed and a piece of flooring already provided be put in place and the room turned over to the Cercle Francaise. Instead of having a fixed blackboard back of the lecture table, he had both the board and the partition back of it so suspended that when the room was to be used for theatrical purposes, they could be raised entirely out of view, thus providing both stage and flies for a neat little theatre. The professor also insisted that all apparatus be removed from this and the other lecture halls at the conclusion of the exercises at which the apparatus was used."

Further, so large an investment as is represented by the grounds and many valuable buildings, and the expensive equipment of the modern college plant ought not to permit the buildings to remain vacant and idle during four months of the year. In a few instances, as at Columbia and at Harvard, this is to some extent overcome by summer schools, which have the advantage of unusual facilities and equipment, and should be made to yield an income.

There are four general principles in scientific management and they are all applicable to a college or to a university; but the economies to be attained through them come about only through the hearty coöperation of everybody who is concerned.

"First, A Large Daily Task.

"Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague nor indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.

"SECOND, STANDARD CONDITIONS.

"Each man's task should call for a full day's work, and at the same time the workman should be given such conditions and appliances as will enable him to accomplish his task with certainty.

"THIRD, HIGH PAY FOR SUCCESS.

"He should be sure of large pay when he accomplishes his task.

"FOURTH, LOSS IN CASE OF FAILURE.

"When he fails he should be sure that sooner or later he will be the loser by it."

But, it is argued, a college has to do with spiritual and intellectual development and the higher mental and moral attainments and interests of life. Undoubtedly this is so, and it is just what we are aiming to accomplish through scientific management, by so readjusting present working conditions as to enable the professors and their staffs to grow and have the opportunity to consider the higher ideals and properly guide the college boys thereto. A high-salaried man should not be doing those things which a lower-salaried man can do very nearly as well. Some one else should do these things for him.

The term "functional management" is given to that phase of scientific management which provides that each man from the highest salaried to the lowest shall have as few functions as possible to perform.

Historically, there has been a good deal done in the line of functional management since early days. In the old district school, one teacher taught everything in the grade. Now, even in the elementary schools, the best of them, one teacher, who is particularly good at reading, or geography, or music, teaches the reading or the geography or the music for several grades and often has no other subject to teach. This is, of course, the case in colleges, for the teaching is departmental. Now this is unconsciously the beginning of functional management, although not technically so called. Scientific study and the conscious application of the principles of management will bring about still further improvement.

Most of the teachers in colleges are men of rare ability who have devoted years to training themselves in a special branch of knowledge. It is a matter of supreme importance to them that they should be able to devote every possible minute of their valuable time to the use of this training and knowledge. Each individual in an organization should count for his maximum.

Under functional management, a man is protected in the performance of the highest kind of work he is competent to do and relieved of the things which can be accomplished by other agencies. Applied to the college, this functional method will mean that the work of any institution will be divided into a large number of functions, and that in each of these functions some one person must be supreme. There is a wide difference between dividing all the work into a certain number of positions, the occupant of each position having many functions to perform, and dividing the work into a certain number of functions, with some one person supreme or expert in each function.

Functional management is based on the belief that there is one best way to do a given thing. This best way can be determined by scientific methods and expressed in complete detail in writing as a standard.

Now how will this help the teacher? Everything must be done to conserve his time. The higher his position, the greater will be the incentive to do this. One of the principal ways of doing this will be in having much of his routine work done for him. Undoubtedly the work would not be done quite as well as the teacher could perform it, and yet it would pay if the time of the professor thus saved could be utilized in more important duties, and the direct return to him would be his ability to command a larger salary as a result. For instance, examination papers are often mimeographed or typewritten. The professor ought not to be obliged to do this himself. There should be a recognized department from which he is entitled and expected to receive a definite mechanical service of that sort.

One thing could be done as an entering wedge. Four professors, not necessarily teaching the same subjects, could arrange together to occupy the full time of a low-salaried instructor, who would perhaps do no teaching or lecturing, but would lighten their labors in the line of correcting examination papers, tabulating results and marks and keeping records, and furnishing them with carefully written reports of the results. He could even conduct examinations, and edit and typewrite the professor's notes and lectures, with the result that each of the professors would be able to take one class more, and would much prefer so doing to carrying on the routine work previously burdening them. Such service would enable them to possess a broader outlook and consider the big things in their respective fields.

It may be argued that the professor cannot keep in close touch with the individual members of his classes and know how his classes are assimilating what he furnishes them, without his actually correcting the examination papers. The answer is that it is possible for the papers to be returned to the professor for his perusal without his being required to put himself in the critical mental attitude necessary to detect each error and determine and affix the exact percentage of excellence. On the other hand, his mental attitude would be one of constructive study and to attain this, a perusal of every paper would not be necessary.

Again, there are many courses that remain practically the same from year to year, and which in the presentation require special apparatus or much mechanical preparation. At present, most of this is done by the man who delivers the lecture or by an assistant who has been trained to do this through years of practice. In industrial establishments, more complicated work than this is frequently done by ordinary workmen under written instructions. There is no reason why, for each lecture there should not be written instructions in complete detail, specifying exact locations, etc., with lists of apparatus, to be given to a low-salaried man. The man might even actually go through the performance of the experiments

in order that the time of the professor might not be wasted when he went over them preparatory to the lecture. This would relieve the professor of much subordinate work that consumes his time.

In organizing these functional activities, the best progress will be made to do things gradually only as they can be well done. It will not be best to require everybody to use a given functional agency when it is first started. Duties will be willingly relinquished to those who will discharge them more efficiently, if thereby relief to do larger things is attained. A purchasing agent will find his time profitably occupied in doing the buying for those who are anxious to use his services, particularly if they are impressed with his efficiency and genuine helpfulness. It will be better for him to make a few purchases and make them right, than to force his services on those who do not feel that they require them. For the result will be that practically every one will turn over the purchasing to him within a year or two, without the necessity of his forcing his services upon him. People always are glad to be relieved of trouble.

Many of the activities of the college are similar to those of ordinary business, such as the buying of supplies for the maintenance and care of buildings, for individual laboratory work, the various forms of printing, reports and catalogues, stationery and office supplies.

The receiving and paying out of money demands an accounting system as comprehensive as that of many a large manufactory or public service corporation. Oftentimes, the care of the college funds is merely a side issue of a man whose mind and inclinations are trained along entirely different lines, along lines of purely intellectual and spiritual pursuits. This, however, is a business matter and should be in the hands of a shrewd, level-headed and far-sighted business man or at least should be handled in a modern business way.

The trustees want to know what things cost and the average institution can only give summaries, and is unable to give a correct analysis or a satisfactory comparison with previous

years. There should be a competent officer, who should devote his entire time to the work, whose business is to study costs, to analyze expenditures according to the teaching departments. For the teaching departments in a college or university are the equivalent of the manufacturing departments of an industrial enterprise. To each should be charged its own direct expense and its proportionate share of all the indirect expenses. The entire expenses, direct and indirect, including the administration, should be divided among the various teaching departments. Such an officer should advise department heads monthly as to the amount of expenditures under their appropriations, and should have authority to prevent expenditure in excess of an appropriation.

The general features of college life, as the library, the chapel and the gymnasium, are operated only because they concern teaching. Following the industrial custom of charging overhead expenses to the various manufacturing departments in proportion to the wages paid in those departments, the net expense of such general features of college life might be charged to the various teaching departments in the proportion of their teaching salaries.

The dormitories, however, as usually operated are producers of income. If, however, a fiscal year shows a deficit instead of an income from the operation of the dormitories, the excess of expense over income may be charged against the teaching departments in a manner similar to the case of the library. The expenses of a building may be charged against the building and at the end of the year divided among the departments using the building in proportion to the number of hours in use.

The fact should be established among all departments that there must be some relation between expense and the amount of work done. At most colleges this can be done by the present accounting staff at no increase in cost.

The typical college building usually has its own janitor. There should be a superintendent of grounds and buildings, in charge also of the power plant and of all shops, with the re-

sult of better service under centralized management. This superintendent may have the direction of a corps of janitors, resulting in improved service and standard and uniform conditions of cleanliness. Methods of housekeeping may be carefully and critically studied and scientifically analyzed, and the best method for each kind of work may be accurately described in writing and adopted as the standard.

Many colleges have dormitories. The average college president has very little idea of the number of helpers really needed in the kitchen, the most convenient arrangement of the dining rooms, and the most efficient method of caring for a large dormitory. The result is that if he happens to hire a good steward or chef, the dining room may be cared for economically and efficiently; if he has a good superintendent, the sleeping requisites and supplies may be bought with wisdom. There is more likelihood that he will get a poor and indifferent employee and the college will suffer in discomfort. If from scientific study of conditions, certain standards along these lines were adopted, it would be comparatively easy to require a new steward or manager to accomplish definite results at given times with a definite number of helpers. Instead of depending on chance, the college would have the accumulated wisdom of its past, in a definite form, recorded in writing, upon which to go ahead and make progress. There would then be no necessity for nor immediate likelihood of aimless drifting. Many a man, when given a standard plan, is able to work satisfactorily in accord with it, and may even improve it. If he depends on his own initiative altogether, he may fail entirely or at the best attain only indifferent success or the commonplace.

An industrial establishment has found the services of the inspector very helpful and profitable in maintaining the quality of its product. It may be possible that the college should have a similar inspecting agency, to attain uniformity in class-room methods, as to quality of teaching and as to class-room discipline, with the motive of quietly averting those conditions that might result in serious harm. Such an in-

spector might develop methods of training men for the teaching staff, for in many institutions most of the assistants are recent graduates without either the teaching, training or experience with the world that would be helpful to them in their relations with the students. As standards are adopted in a college, it will be necessary to have an agency whose special function will be to see that such standards are properly formulated and maintained in force. This duty might be assigned to the inspector.

The development of the function of purchasing agent will naturally lead to the concentration of supplies of all kinds in one central storeroom, from which everything used in all departments may be obtained, at a great saving of time, money and convenience.

The economical use of the buildings, the planning whereby the various rooms may be utilized each for many more hours per day might be one of the duties of the registration department. And in consequence, the registrar should be responsible for the planning of the hours of the day when courses are to be given, for he has the records indicating the desires of the students as to the courses which they wish to take. If rightfully and tactfully handled, many students would be led to plan out their courses more intelligently and more consistently, and the assignment of classes to rooms could be more easily handled.

Among the results of the application of scientific management, there will be a more genuine and hearty coöperation among the colleges and universities, in the interchange of helpful information and data, and even of members of the teaching staff, who will find themselves as much at home in the atmosphere of one institution as in another. Owing to the adoption of standard methods and standard records based on scientific study, comparisons of costs and efficiencies will lead to more intelligent administration and the more effective training of men for coping with the practical problems of to-day.

COLLEGE NOTES.

Colorado School of Mines.—A recent important addition, which has been made to the equipment of the Colorado School of Mines, is a new 14-foot Littrow Spectrograph purchased at a cost of $1,500 through the Vinson Walsh Research Fund. This fund was given by the late Thomas F. Walsh for the determination and study of rare metals in ores.

The instrument is located in the department of physics. Professor L. F. Miller is in charge of this department. No new principle is involved. The finely ground ore to be tested is burned in an electric arc. The light from the flame is broken by passing through prisms into the colors of the spectrum. This spectrum is viewed through a powerful telescope and if any mineral is present, even in the most minute quantity, a certain line corresponding to the mineral will be seen in the spectrum. Since spectrographic methods are thousands of times more sensitive than most chemical or assay methods the instrument is especially serviceable in determining the rare metals. With the present knowledge, only qualitative tests can be made, but to predict that before long quantitative tests can be made is no more visionary than to have predicted twenty years ago that we would be flying through the air today.

Because of its sensitiveness the spectrograph has been used to detect adulterations and many cases of poisoning. It has been used to a limited extent to study the flames from steel and copper converters, as a means of gauging the different stages in the process. There is still a large opportunity for investigation in this direction.

Through the Vinson Walsh Research Fund this department has already been equipped with all the necessary apparatus to determine radioactive metals. With the new specially constructed spectrograph the school is in a position to cover fully the entire rare metal field.

University of Illinois.—Mr. Jacob Johann, of Springfield, Illinois, for many years identified with the Illinois Central Railway and for many years an active member of the American Railway Master Mechanics' Association, has presented to the library of the University of Illinois a complete file of the *Proceedings* of the American Railway Master Mechanics' Association and a collection of miscellaneous volumes of interest to the department of railway engineering. Mr. Johann was president of the Master Mechanics' Association for the year 1886–87, and is now one of its distinguished honorary members.

Michigan College of Mines.—The following changes occurred in the last year: Department of mechanical engineering: Prof. O. P. Hood, head of department, resigned to accept the position of chief mechanical engineer, U. S. Bureau of Mines, located at Pittsburgh, Pa.; Prof. George L. Christensen has been promoted from assistant professor to professor and head of department; Mr. William Anderson has been promoted to assistant professor of mechanical engineering from instructor in mathematics, physics, and electrical and mechanical engineering. Department of mineralogy and geology: W. E. Hopper has been appointed instructor in economic geology to succeed W. A. Paine, resigned. Department of metallurgy and ore dressing: T. G. Chapman has been appointed instructor in metallurgy and ore dressing to succeed H. L. Roscoe, resigned. The gym: H. H. Coryell has resigned as instructor in physical training. His successor has not been appointed.

University of Minnesota.—On May 6, 1912, at his own request and because of physical disability, the board of regents of the University of Minnesota voted to retire Dr. Arthur E. Haynes, professor of engineering mathematics. The board in its action also voted to express its appreciation not only of the professional services of Professor Haynes, but of his personal devotion, his influence for the highest type of living and his loyalty to the University. Professor Haynes has taught stead-

ily over 36 years: in Hillsdale College 15 years, The Michigan College of Mines 3 years and in The University of Minnesota over 18 years. Professor Haynes has always been a friend to young men, and few college teachers have been so well known and few so much beloved. Upon his retirement Dr. Haynes was placed on the Carnegie pension list to take effect June 1, 1912.

Professor Geo. D. Shepardson, head of the department of electrical engineering, in the College of Engineering, University of Minnesota, who has been on leave of absence during the year, engaged in study at Harvard University, has just been granted, by unanimous vote of the Harvard Faculty, the degree of Doctor of Science. Dr. Shepardson will return to his work in the University of Minnesota at the beginning of next semester.

Professor William E. Brooke, of the College of Engineering, has been appointed to fill the vacancy caused by the retirement of Dr. H. T. Eddy, head of the Department of Mathematics and Mechanics. Dr. Eddy after long and efficient services, retires, on Carnegie allowance, at the age of 68. Dr. William F. Holman, takes the place made vacant by the retirement of Dr. Arthur E. Haynes, from the Professorship of Engineering Mathematics.

Throop Polytechnic Institute.—Plans for 1912–1913 provide for a material extension of the work in chemistry, especially organic chemistry and petroleum technology. Provision has been made in the Budget for an enlargement of the chemistry laboratory, and material additions to the equipment; and the staff of the department has been increased by the appointment of Dr. Richard S. Curtiss, now professor of organic chemistry in the University of Illinois, as professor of organic chemistry and research associate; and of Charles Andrew Brautlecht, now a candidate for his doctorate at Yale, as instructor in chemistry and physics. Dr. Curtiss has done notable work in organic chemistry. His Bachelor's degree is from Sheffield, and his Doctor's degree from the

University of Wurzburg. Mr. Brautlecht is also a graduate of Sheffield Scientific School in the class of 1906. Dr. William R. Flint, who has been in the department the past year, will be professor of inorganic chemistry. Material additions to the equipment of the engineering departments are provided for in the budget of the Institute for 1912–1913, and there has been a general advance in salaries. The budget also makes provision for sending two members of the Faculty to the Bureau of Standards at Washington for a study of the work of the Bureau, and to a number of the leading technical schools of the East and Middle West for a study of methods in use in these institutions. While the attendance has not been large, the first year of exclusively college work by the Institute has been very successful in the character of work accomplished, and prospects for the coming year are very satisfactory and give promise of a reasonable increase in enrollment.

Tokio Imperial University.—In the College of Engineering, the instruction in experimental engineering is now occupying the attention of the faculty more than ever. As a renovation, there is under consideration the plan of centralizing all the engineering laboratories, which are now divided among several departments, to a common one. Such an arrangement, properly carried out, is expected not only to lead to a greater economy, but also to improve the equipment and make it more effective. Difficulties present themselves, nevertheless, when it is remembered that the College consists of ten departments, viz., civil engineering, mechanical engineering, naval architecture, technology of arms, electrical engineering, architecture, applied chemistry, technology of explosives, mining, and metallurgy, and each department has its own particular work of investigation or practice to carry out. A committee has been appointed and is now discussing the proposed plan.

A recent accession to the equipment for experimental work may be mentioned—the masts and stations for wireless telegraphy. Another addition now under way is a marine laboratory at Cape Taits for the investigation of tides and waves, and of the behavior of engineering materials in sea-water.

West Virginia University.—Professor Edwin Nathan Zern of the University of Pittsburg has been appointed to fill the Chair of Mining Engineering at the West Virginia University. The Board of Regents of the University have decided to establish an extension course in mining and to employ additional instructors to carry on this work.